PUBLIC DOCUMENT No. 1

TENTH ANNUAL REPORT

OF THE

NORTH DAKOTA

Agricultural Experiment Station

AGRICULTURAL COLLEGE, N. D.

TO THE

GOVERNOR OF NORTH DAKOTA

FEBRUARY 1, 1900

GRAND FORKS, N. D.:
HERALD, STATE PRINTERS AND BINDERS
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LETTER OF TRANSMISSAL.

FARGO, N. D., February 1, 1900.

To His Excellency Governor F. B. Fancher,
Governor of the State of North Dakota:

Sir: As required by Act of Congress, approved March 2nd, 1887, and section 13, chapter 160 of the Laws of 1896, for North Dakota, I hereby submit the Tenth Annual Report of the North Dakota Agricultural Experiment Station for the year ending February 1st, 1900, together with a financial statement of receipts and disbursements, as required by law, for the government fiscal year ending June 30th, 1899.

Very respectfully yours,

W. H. ROBINSON,
President Board of Trustees.

REPORT.

To the Board of Trustees of the North Dakota Agricultural College and Experiment Station:

Gentlemen: I have the honor to submit to you the Tenth Annual Report of the North Dakota Agricultural Experiment Station. The past season has been favorable for experimental work and the several departments have made good progress and collected much data that will prove valuable to the agricultural interests of the state.

Eight Bulletins were published during the past year:

No. 35 by Professor E. F. Ladd—Some Chemical Problems Investigated.

1. A Case of Poisoning.
2. Soil Studies and Humus.
3. A Glucoside of Millet.
4. Sugar Beet Experiments.
5. Nitragin Experiments.
6. Florida Velvet Beans.
7. Preserving Eggs.

No. 36 by A. M. Ten Eyck, assistant Agriculturist—A Study of the Root Systems of Wheat, Oats, Flax, Corn, Potatoes, and Sugar Beets, and of the Soil in Which They Grew.

No. 37 by Professor H. L. Bolley—The Prevention of Smuts of Cereal Grains, and Prevention of Potato Scab.

No. 38 by Professor J. H. Shepperd, and Assistant A. M. Ten Eyck—Cultivation Experiment with Wheat and a Special Study of the Moisture and Temperature of the Soil Under the Campbell and Ordinary Treatments.

No. 39 by Professor J. H. Shepperd, and Assistant A. M. Ten Eyck—Variety Tests; Thickness and Depth of Planting Grain, Forage and Root Crops, Changing Seed Wheat, Rotation of Crops.

No. 40 by Professor J. H. Shepperd—Grasses and Forage Crops.

No. 41 by Professor C. B. Waldron—Some Hints on Ornamental Planting.

No 42 by Professor C. B. Waldron—Field Notes of Horticultural Department.

A combination sheep and pig frame barn, 36 by 48 feet, one and one-half story, was completed during the summer of 1899. This barn also provides a suitable room for classes in stock judging.

The poultry yards have been greatly enlarged and otherwise improved, and the barn, implement shed, poultry house, farm house, and dairy building have been newly painted. The main stock barn

was raised in the center and substantial pillars placed underneath. This was made necessary on account of the soft foundation and consequent sinking of the building.

Over twelve hundred farmers living along the line of the Great Northern railroad and its branches availed themselves of the generous conditions offered by its president, Mr. James J. Hill, and visited the Experiment Station during the months of June and July.

In addition to their duties as experimenters, the members of the Station Staff are required to do a considerable share of the teaching, especially during the winter term, when large classes of young men are formed for instruction in almost every branch of Agricultural Science.

Farmers' institutes have been held at Lidgerwood, Dwight, Gardner, Larimore, Lakota, Blanchard, Enderlin, Park River, Fingal, Wimbledon, Carrington, Harvey, Minnewaukan and Leeds.

At many of the above named places permanent organizations were effected for future regular meetings to discuss subjects affecting agriculture and animal husbandry. A large number of institutes are scheduled for February and March, and some later in the season. The demand for institutes is beyond our ability to fill. With the present over-crowded condition of the school, the Station Staff is required to work over time, without taking into account the institute work.

The state should make ampler provision for farmers' institutes. Farmers are entitled to some recognition, for money expended thus brings back to the state positive returns. Our soil is our pride and our hope, and to till it well and scientifically means great and continuous wealth; to till it otherwise must result in soil exhaustion within a few years, or at most within a few decades. The decreasing average yield of wheat per acre is already marked. The state cannot long overlook a matter so important as the foundation of our future greatness and prosperity. It is as marked an evidence of patriotism to preserve our soil as to preserve our institutions of liberty, and future generations will so consider it.

CHEMICAL DEPARTMENT.

To J. H. Worst, Director:

Sir: In submitting my Tenth Annual Report, for the year 1899, I present only a synopsis of the department work along certain lines, leaving the material for publication in bulletin form.

During the past year one bulletin was prepared and published by the Chemical Department, consisting of 26 pages treating of the following matters:

1. A Case of Poisoning.
2. Soil Studies and Humus.
3. A Glucoside of Millet.
4. Sugar Beet Experiments (in 1898).
5. Nitragin Experiments.
6. The Flordia Velvet Bean.
7. Preserving Eggs by Means of Water Glass.

Readers who may be interested in any of these questions are referred to Bulletin No. 35.

The work of the Chemical Department is greatly handicapped for want of proper room in which to conduct lines of investigations where time or the control of conditions, as temperature, etc., are factors. Our laboratory is too small for the required college work and there is not a single room that can be set aside for station work. At the earliest possible time additional room should be furnished and the station laboratory should be separate from all lines of student work.

The amount of routine work for the past year has been exceptionally large, and has consisted of analysis of waters for farmers, identification of specimens, minerals, clays, coals, ashes, etc. So great has been the demand that pretty nearly all of the time of one person has been given to this line of work. Several samples of milk and many food products have been examined, also samples of formaldehyde to determine the strength for use by farmers in treating wheat for destroying smut spores.

Much of the analytical work has been conducted by my assistant, Mr. Hugh McGuigan, who has faithfully performed his part of the work.

FOOD PRODUCTS EXAMINED.

Several food products have been analyzed, the results of which may be of general interest, and are presented in the following table:

Number		Water	Ash	Fat	Albumenoids or proteids	Crude Fiber	Nitrogen free extract
1	Wheat Grits	8.15	0.72	1.39	12.07	0.63	77.04
2	Cream of Wheat	4.77	0.43	1.29	11.37	1.46	80.68
3	Scotch Fife Wheat	9.33	1.88	2.83	13.62	3.48	68.85
4	Blue Stem Wheat	9.26	1.97	2.71	14.06	3.41	68.59
5	Flax Bolls	10.41	4.29	3 45	0.40	42.03	29.42
6	Spelt (Seed)	10.03	1.85	2.80	11.69	2.94	70.69
7	Spelt (Husk)	4.62	13.58	1.64	2.81	36 68	40.67
8	Wheat Flour	8.11	0.39	1.18	14.62	0.25	75.45

No. 1 is a breakfast food called "Golden Heart Wheat Grits," made in Moorhead, Minn.

No. 2 is a sample of breakfast foods put up in Minneapolis.

No. 3. Sample of Scotch Fife wheat from the Mandan Flour Mill, grown on new breaking and yielding 23 bushels per acre.

No. 4. Sample of Blue Stem wheat from same source, grown on old field, yielding 16 bushels per acre.

No. 5. A sample of flax bolls or hulls from the fibre mills at Fargo.

No. 6. A sample of spelt seed grown on College farm free from hull or husk.

No. 7. Spelt husks removed from seed No. 6.

No. 8. A sample of wheat flour from the Jamestown Flour Mills.

Three samples of beef were analyzed. No. 1, sample of porterhouse steak from a three year old steer. No. 2, sample of leg roast from same animal. No. 3, sample of leg roast like last but taken from a seven year old cow. The analysis presented are for the meats after roasting.

	2	3	1
	3 Years Old.	7 Years Old.	Porterhouse 3 Years Old.
Water	48.04	50.61	46.35
Ash	1.04	1.03	1.00
Albumenoids	24.00	22.38	20.28
Fat	24.83	23.16	30.57
Extractives, etc	2.09	2.82	1.80
	100.00	100.00	100.00

Artificial digestion experiments were made, using pepsin for testing the relative digestibility of these meats.

	Percent Digested of the Cooked Meats at the End of 1½ Hours.	3 Hours.	18 Hours.
Porterhouse	89.10	90.60	95.50
3 Year Old	88.70	91.20	94.70
7 Year Old	86.90	90.00	94.80

Artificial digestion experiments were also made upon the fresh

uncooked samples with results as follows for amounts digested at end of:

	3 Hours.	6 Hours.	18 Hours.
Porterhouse	95.4	94.8	96.3
3 Year Old	91.7	93.8	95.2
7 Years Old	91.6	93.2	95.2

MISCELLANEOUS ANALYSIS.

Several coals have been examined, and since the western part of the state is so largely underlaid with lignites and the principal source of fuel for its farmers and for many industries, the following analysis will be interesting, as showing the composition of the product from one of the mines, air dried:

	Per cent.
Water	13 29
Volatile Carbon	38.09
Fixed Carbon	46.00
Ash	2.62
	100.00

We have also been frequently asked regarding the composition of the ashes from lignite, and the following shows the composition of a sample of such ashes sent in from Mandan.

	Per cent.
Insoluble matter, Si 0 2	29.54
Sulfuric acid, S 0 3	1.16
Magnesia, Mg 0	trace
Lime, Ca 0	16.24
Iron Fe, 2 0 3 / Alumina, Al 2 0 3	26.52
Potash, K 2 0 / Soda, Na 2 0	23.44
Carbon, unconsumed	4.44
Carbonates and undetermined	8.66
	100.00

SOIL INVESTIGATION.

The work in soil analysis has been continued during the past year and many new lines of work in the humus problem undertaken and much interesting data secured to be published as a bulletin at a later date.

CLAY DEPOSITS.

A large number of clays and other similar deposits have been examined for parties in different parts of the state, and some of the results of analysis are presented in the accompanying table:

	1	2	3	4	5	6	7	8	9
Insoluble *matter Si o 2*	12.72	25.43	70.00	52.22	58.88	58.60	71.10	79.55	16.35
Alumina, Al 2 0 3	5.27	10.72	17.19	18.26	15.40	22 97	12.88	14.26	6.12
Iron Fe, 2 0 3	2.51	3.60	3.47	8.70	5.60	1.12	2.62	0.84	1.68
Lime, Ca 0	40.75	28.39	0.90	trace	trace	trace	trace	trace	24.30
Magnesia, Mg 0	1.62	1.23	0.85	trace	trace	trace	trace	trace	0.48
Sulfuric acid, S 0 3	3.15	3.90	3.07	0.52	0.68	0.50	0.29	?	15.92
Potash, K 2 0	----	----	----	2.40	2.40	0.66	1.26	0.61	----
Soda, Na 2 0	----	----	----	----	----	----	----	trace	----
volatile matter	34.64	26.16	5.00	18.78	17.66	15.62	12.95	4.54	35.79
	100.66	99.43	100.48	100.88	100.62	99.77	101.10	99.80	100.64

No. 1. Sample sent by B. G. Skulason, Grand Forks, and said to be from the Pembina Mountains.
No. 2. From same source, but somewhat different specimen.
No. 3. Clay from near Langdon, North Dakota.
No. 4. Sample from G. B. Olgeirson, Gardar, N. D., from ravine 300 to 400 feet deep. Taken about 30 feet from bottom.
No. 5. Same source as last. A 20-foot vein.
No. 6. From same source as last, in six inch layers.
No. 7. Same source as last, but nearly black in color.
No. 8. Sample sent in from Hebron. Taken from outcrop on side of bluff about 17 feet in thickness for deposit exposed.
No. 9. A sample from Lisbon, North Dakota.

SUMMARY OF TEMPERATURE, RAINFALL AND SUNSHINE.

The following tables give the maxima, minima and mean temperature for each month, also the total rainfall by months and the hours of sunshine:

	Maximum	Minimum	Mean	Rainfall	Hours sunshine recorded	Hours sunshine possible	Percentage of possible am't.
January	39	-26	....	0.29	87.3	261.0	32.3
February	50	-37	0.4	0.29	141.6	287.9	49 2
March	53	-17	8.0	1.58	206.9	368.9	61.6
April	81	-10	41.1	1.39	244.0	424.9	57.4
May	84	23	52.5	4.22	182.5	453.1	40 2
June	88	38	63.8	3.44	240.0	475.5	50 5
July	94	40	68.4	2.78	297.0	481.5	61.7
August	89	37	67.2	3.71	198.0	395.9	50.0
September	92	17	55.2	1.24	222.6	377.8	58.9
October	73	21	43.7	1.67	100.4	336.6	29.8
November	64	9	36.0	0.27	110 7	287.2	38.6
December	46	17	14.6	0.33	127.6	267.1	47.3
				21.21	2158.6	4516.4	47.8

The hours of actual sunshine is the amount recorded by means of the Friez Photographic Sunshine Recorder and contains no twilight correction. Of actual sunshine not recorded by this photographic method I estimate about 12 per cent to be added to the above figures. In summer there may be added two to four hours additional daylight before and after sunset.

The total rainfall for each of the several years since our record began is given below:

	1892	1893	1894	1895	1896	1897	1898	1899
Total rainfall	20.73	16.17	18.72	16.85	20.36	22 30	16.20	21.21

This gives a mean annual rainfall of 19.87 inches for the past eight years.

SUGAR BEET EXPERIMENTS.

During the past year this department, in co-operation with the Department of Agriculture at Washington, has continued the sugar

beet experiment. There was sent out seed to 295 farmers, only 89 of whom sent in samples of beets for analysis during the past fall. Of this number 82 samples were received in proper condition for analysis.

The following table gives the results of the analysis for the several samples examined.

Seriel Number	NAME.	ADDRESS.	Per cent. Sucrose	Coefficient of Purity
7	Leffingwell, W. H.	Ludden	15.90	84
9	Cochran, W. L.	Wyndmere	14.64	92
12	Kinney, James M.	Wyndmere	13.42	84
14a	Hackney, Geo. D.	Valley City	10.28	73
14b	Hackney, Geo. D.	Valley City	13.44	79
18	Whelan, Thos. K.	St. Thomas	11.26	72
27	Wickstrom, P.	Lisbon	13.94	87
31	Wilmort, Emile	Montpelier	11.40	87
32	Blakely, J. C.	Hope	15.44	77
39	Hilbert Bernard	Bac	13.84	77
43	Eddy, E. C.	Fargo	10.72	52
*45	Mitchell, Peter	New Rockford	11.44	72
47	Lapierre, Joseph	New Rockford	15.96	88
49	Shanahan, P. J.	New Rockford	14.60	86
50	Galepski, Frank	Ardoch	8.68	67
53	Bullis, H. E.	Maple	12.34	77
54	Comtemanche, H.	New Rockford	11.26	71
55	Conlin, Martin	Eckleson	13.84	62
56	Johnston, S. C.	McRae	12.60	84
63	Jolliff, R. O.	Rolla	12.88	80
64	Finnie, D.	Emerado	15.00	83
72	Stark, F. J.	Akra	13.80	85
74	Philips, Richard	Albertha	18.48	90
80	Todd, G. H.	Oakes	9.82	75
82	French, N. S.	Grand Rapids	11.44	81
83	Myren, P. P.	Hillsboro	14.64	77
84	Parker, R. A.	Bottineau	13.42	84
86	Salter, H.	Mapes	17.94	91
89	Pinkas, V. C.	Absaraka	15.44	85
91	Tracy, G. W.	Dale	12.24	80
92	Smyth, J. N.	Verona	12.88	80
93	McDonald, E. H.	Hamilton	10.44	74
95	Campbell, Bernard	Buchanan	10.24	69
104	Rainsberry, N.	Lakota	8.72	72
105	Kirby, N.	Buttzville	13.54	84
106	Watt, Wm.	Leonard	13.00	87
110	Brock, J. B.	Williamsport	12.08	75
112	Bourassa, A. N.	St. John	15.32	85
114	Brosins, Nic	Anton	10.24	73
116	Harrington, J.	Jamestown	14 00	65
117	Bales, O. L.	Dale	15.84	79
118	Hauser, J.	Winona	15.34	77
121	Tufts, D. E.	Sharon	12.42	77
122	Overmoen, J. J.	Hillsboro	16.90	85
124	McPherson, A.	Sterling	lost	
127	Lindblom, P.	Wyndmere	11.50	72
130	Hill, E. L.	Maddock	15.54	81
133	Stanlep, C. H.	Steele	13.46	90
141	Estinson, J. C.	Hickson	12.36	83
143	Jungintsch, A.	Page	13.92	92

CONTINUED.

Seriel Number	NAME.	ADDRESS.	Per cent. Sucrose	Co-efficient of Purity
144	Bovie, C. B.	Jamestown	15.62	87
145	Toay, Michal	Jamestown	12.34	77
147	Jasper Joseph	Woodhull	13.18	88
149	Coghlan, Jas.	St. John	10.82	72
166	Erickson, E. A.	Portland	10.36	74
168	Fleck, J.	Richardton	14.60	81
170	Wells, T. G.	Lisbon	13.06	76
173	Carpenter, S.	Barton	10.78	72
174	Nordvie, C.	Trysil	9.74	69
175	Craig, R. S.	New Rockford	14.96	83
183	(a) Olmsted, S. A.	Ludden	13.12	77
183	(b) Olmsted, S. A.	Ludden	15 64	94
184	Mathison O.	Trysil	13.94	82
190	Quinlin, J.	Cavalier	11.00	78
207	Powell, R. F.	Cando	7.70	64
209	Beaudouin, A.	St. John	16.40	86
210	Schneider, Wm.	Dazey	17.62	93
213	Jacob, P.	Hankinson	9.70	45
214	Farley, K. C.	Ashley	11.44	71
226	Bowser, W. H.	Perry	12.14	86
231	Taylor, L. B.	Fairmount	11.80	79
232	Kartner, H.	Forman	10 84	72
238	Lewis, Frank	Tiffany	12.82	75
246	Bietz, Gosslieb	Ostrem	13.26	67
249	Widmeyer, G.	Rolla	12.60	42
254	Johnson, C. S.	Lowell	12.20	81
260	Veum, K. J.	Hoople	17.62	89
264	Wesley, George	Fisher	15.38	77
267	Kine, Wm.	Fisher	13.72	55
268	Wesley, Jess	Fisher	13.04	76
273	Smith, Mrs. M. E.	Fisher	11.80	74
283	Mitchell, R.	Hample	9.40	75
284	Agricultural College	Fargo	8.72	73
285	Agricultural College	Fargo	11.20	75
286	Agricultural College	Fargo	12 44	88
287	Agricultural College	Fargo	9.94	71
288	Agricultural College	Fargo	11.40	76
289	Johnson, C.	Oakes	11.74	78
		Mean of all	12.90	78

The seed furnished by the Department of Agriculture was of three varieties, "Vilmorin's Improved White" (2378); the "Zehringen" (2379), and "Mangold" (2884).

The following table shows the average, maximum and minimum for each of these varieties and number of samples tested:

	Vilmorin's.	Zehringen.	Mangold.
Number Samples	11	12	64
Maximum	15.64 per cent.	15.90 per cent	17.94 per cent.
Minimum	11 50 per cent.	10.24 per cent.	7 70 per cent.
Mean	13.96 per cent.	12.55 per cent.	12.85 per cent.
Co-efficient of Purity	62	.81	79

The year has been generally unfavorable and farmers in sending in their reports state quite generally that the season was not favorable for best results. Again, often the ground was not properly prepared nor the beets well cared for during the summer.

Respectfully submitted,

E. F. LADD,
Chemist.

DEPARTMENT OF BOTANY.

To Director J. H. Worst:

Sir: The station work which I have to report upon for the year ending December, 1899, may be summarized under about five general headings:

Studies Upon Cereals; Weed Studies; Selection of Potatoes; Bacterial Investigation and Microscopical Examinations; and Miscellaneous Work.

During the year the department had the assistance of Mr. Merton Field until the close of the month of July. Since September 1st, Mr. Lawrence Waldron has been assistant to the department in teaching and station work. About one-half of Mr. Waldron's time can be had for station assistance.

A.—STUDIES UPON WHEAT AND OTHER CEREALS.

I have considered that the cereal grains and grasses are the plants about which the people of this state have the greatest desire for information. I have therefore given most of my time, open to station work, to various studies and observations upon these plants.

STUDIES IN WHEAT SELECTIONS, OR RATHER OBSERVATIONS UPON THE GROWTH AND PRODUCTS OF WHEAT PLANTS OF KNOWN SELECTED PEDIGREE.

It has often occurred to me that it could be possible to demonstrate the principles upon which rational wheat selection might be based. Present best practice calls for so screening seed wheat that the seed sample is reduced to an even quality of large heavy grains. There is, however, a difference of opinion as to what wheat grain is the best one to plant. Some farmers contend that a small hard grain is as good as a larger one. In fact, when the subject is thoroughly canvassed, the results of the canvass leave one confused as to the facts. Again many seedsmen have theories concerning the value of certain grains in the individual wheat head.

The probability of gaining any very definite information upon such questions, it seems, lies behind many years of patient observation yet when undertaken there are always side facts which come to light sufficient to pay for the effort. In 1895 I started a series of wheat grain selection. The work laid out may be summarized about as follows, using the following types of seed wheat.

a. { 12 smallest normal grains in one head.
   { 12 largest normal grains in same head.

b. 6 lowest normal grains in one head
6 highest or tip normal grains in same head.

c. 6 grains from the outside rank of grains from four ranked heat.
6 grains from middle rank of grains from four ranked heat.

d. All of the grains from a large mature head.
All of the grains from a small unmature head from the same stool.

These plantings were undertaken for a number of duplicate tests upon a very finely prepared soil, and the following records were taken in each case:

Before sowing—Form and color of the grains; and the total weight of the grains.

After gemination—Notes on growth, number stools, number straws, total weight of straw and grain, total number of grains in the largest head, and the total length of the largest best straw, were taken and the best head for the year was kept and photographed.

The spring of 1896 found the department so fully occupied with teaching and with other station work that it was impossible to carry on the work as planned. The recorded wheat heads were stored in the laboratory, unthreshed.

Last spring (1899) an examination found that the grains had retained viability so that it was yet perfect.

From these heads the work was again undertaken; but upon a much more limited plan. Plantings were made only from the six largest normal grains and from the six smallest normal grains of each head. In each case the small seeds averaged less than one-half the weight of the large ones.

Along with the test there was planted hand picked grain as follows: 1,600 smallest perfect grains, the total weight of which was 35 grammes, and 1,600 largest grains, the total weight of which was 50 grammes. The total product from the experiment was: From large seed, 20 pounds, 14 oz. of straw and grain; from small seed, 18 pounds, 2oz. of straw and grain. This gave a difference of two pounds 12 oz. in favor of the 1,600 large seeds.

The total results of the two years work are very interesting but must be studied in detail to be of value for comparison.

This line of work will now be continued from year to year, as it gives promise of affording valuable information. (Lab. Book 9, pp 66, 65, 93.)

THE WORK WITH THE SMUT OF CEREALS—CONDITIONS OF GROWTH.

Since 1895 effort has been made to ascertain the influence of different dates of seedings, soil conditions, climate, heredity, etc., upon the growth of smuts and rusts. The difficulty of attacking this question lies in the fact that every hour of the growing season introduces a different condition of soil and air. The tests conducted upon the smuts have given some good results, making it less difficult to explain some of the peculiarities of these diseases, their appearance and non-appearance in a crop from the same seed in the same season, etc.

In the case of stinking smut of wheat (*Tilletia*) the following general statements may be drawn from my observations. They may need future modification, but I think that, in the main they will be found to hold good. They have been formulated after a comparison of the results of tabulated daily observations upon the growth from daily plantings of smutted wheats—associated with daily observations upon the physical conditions of the air and soil; and after consideration of laboratory studies upon the smut plant and its host. The details are too extensive for this report: (1) *Tilletias* of wheat in this region grow well if left exposed to the weather in the unbroken "smut balls" throughout the winter months. (2) For best germination, normal spores demand that condition of soil atmosphere which approaches saturation. (3) The presence of actual water in the soil is detrimental to the infection of wheat. (4) The range of temperature for the germination of spores is wide when atmosphere moisture in the soil is right. (5) A low atmospheric humidity associated with a comparatively dry soil and a minimum temperature ranging higher than 40 degrees during the ten days following seeding seems unfavorable to the development of the disease in a wheat crop. (6) The same conditions as those last stated with a minimum temperature ranging from 15 to 35 degrees Fahr. during the period from five to ten days following the seeding time tends to give an increased infection. (7) The best soil conditions for a high percentage of infection in the field may be stated to be that one which will give a good growth of the wheat plant for about four days associated with a saturated soil atmosphere and a daily temperature showing a minimum of 15 to 35 degrees Fahr. during the next following four or five days, followed by a normal season's growth. The season of 1897 started out April 15th with the seed bed in very fine condition as to soil texture and moisture. The conditions became continually dryer until May 19th with but one or two intervening showers. The year was thus particularly a suitable one for those tests. The same sample of smutted seed wheat gave very different results upon different dates of seeding—at one time, 17.5 per cent. of smut, at other times, a less amount and for a time none of the samples of smutty seed wheat produced smut. (8) These variations were found to agree in a marked manner to certain variations in soil moisture and temperature. In the same tests smutted millet was seeded also. It was found to develop less extensively when the seed bed was comparatively dry for some days after the date of seeding. When the ground was too wet to produce a large growth of wheat smut (*Tilletia*), the growth of millet smut was the greatest. The range of smutting in the millet was 9.2 per cent. of smutted heads from the seeding date of May 14th to 30.7 per cent. of smutted heads from the seeding of June 14th. These two dates represent respectively the dryest and the wettest seed bed for the week following the germination period. (9) Thus it is probable that each species of the smuts will be found to give variations as to these matters of condition. There are indications also that weather con-

ditions throughout the growing season which influence the growth of the host plants also indirectly influence the development of the smut in the crop.

TESTS OF TREATMENT IN 1899.

(1) The Use of Formaldehyde Fumes for Grain Disinfection.—Following the tests of 1898 in which it was found that on a small scale fumigation of grain could be successfully accomplished with formaldehyde, I undertook to ascertain in the labatory the range of possible treatment. A small laboratory fumigator was constructed upon the plan of figure 1, p. 23. A number of tests were made upon wheat, oats and barley. A record was afterwards taken upon the effect upon germination, and finally the resulting growth of the seeds in the garden was observed. The following table shows chief points of interest, as to wheat:

Kind of Seed.	How Treated.	Germination Record.				Result in Crop.
		Strong	Medium ..	Weak	Total	
1.—Wheat ..	Fumigated 20 minutes	80	12	4	96	Fine crop, 10 per cent. smut.
2.—Wheat ..	Fumigated 30 minutes.	85	15	..	100	Heavy crop, 9 per cent. smut.
3.—Wheat ..	Fumigated 40 minutes	79	17	4	100	Heavy crop, 10 per cent smut.
4.—Wheat ..	Fumigated 50 minutes.	80	19	1	100	Good crop, trace of smut.
5.—Wheat ..	Fumigated 1 hour.	75	20	4	99	Trace of smut, weak first growth.
6.—Wheat ..	Fumigated 1½ hours.	74	14	7	95	1 per cent. stinking smut.
7.—Wheat ..	Fumigated 2 hours.	57	21	11	89	First growth weak, thin. Good crop. Stinking smut present.
8.—Wheat ..	Fumigated 12 hours.	00	26	18	44	Thin crop; no smut.
9.—Wheat ..	Untreated.	80	10	6	96	Good crop: 10 per cent. smut.
10 Fletcraft's Wheat ..	F'g'd 45 m by Formochloral.	..	15	5	20	Thin crop; 4 stools of stinking smut.
12.—Wheat ..	Untreated.	..	10	80	90	Thin at first; 50 per cent stinking smut.
13.—Wheat ..	Dipped in sol. of Formaldehyde 1lb. to 45g.	8	82	8	93	Good first growth; no smut in crop.

There were many other of these small laboratory tests conducted upon different samples of smutted wheats with results about similar to those given in the foregoing table. The results of these laboratory tests did not give much hopes of success upon the field plan; but from them, much was learned of value as to the action of the fumes of formaldehyde upon seed grain. (1) It was observed that the smut spores still retained the power of germination long after much weak wheat was killed or much injured. (2) That in all probability the fumes are effective in killing smut spores chiefly because of the presence of moisture in connection with the spores. Hence the regular solution is most regular in action. It was also noticed that

weak or soft wheats were also very quickly injured by the application of the fumes, while dipping such wheats in the standard solution of formaldehyde for smut prevention improved the strength of the first growth. Compare numbers 10, 12 and 13 of the table.

In the work with barley and oats this was made much plainer. It was found that for these soft grains, which are very much more liable to decay at germination time than wheat, fumigation in the presence of steam greatly strengthened the first growth from the seed, there being a length of time for exposure which killed most fungi and bacteria of decay and left the grain so nicely disinfected that when placed in a clean germinator no decay or molding occurs while germination is not retarded. This result is well attained by the use of the liquid treatment, but I found it difficult to control in the practice of fumigation. (Note book No. 9, pp. 212-221.)

Treatment In the Field.—The fumigation experiments were given a thorough trial upon a field plan, and I think together with the foregoing laboratory tests practically settles the question of the practicability of the process for farm use. The accompanying figure 1 represents a section view of the apparatus used. A galvanized cylindrical tank was construced, as there represented, capable of

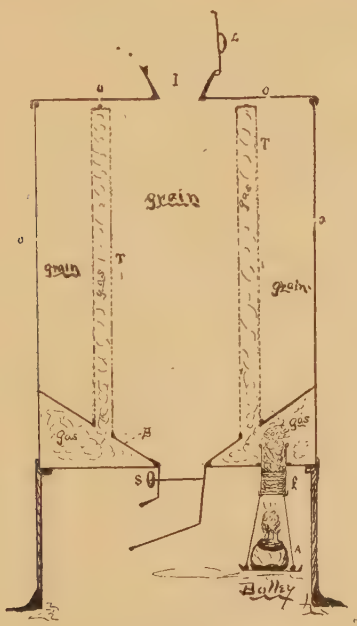


FIGURE 1.

holding 15 bushels of grain. It possessed a second or inside bottom (b) perforated at eight points upon which stood 2½-inch perforated tin tubes (T). Gas was gerated by evaporating liquid formaldhyde

(f) over a burner at (A). The gas entered the tank below the inside bottom, and there were furnished small openings for the escape of air and gas at the points marked (o) so that the entire body of grain was quickly permeated by the gas. This was speedily recognized as accomplished, for within a few minutes after our machine started it was found almost impossible to live in the immediate neighborhood. This would prevent the process from being of practical use on the farm, even were it otherwise a success. The cost of making a fumigation machine which would allow of ordinary methods of work, it seems, would be too great to be desirable. Lime water was added in small amount to the formaldehyde to prevent the formation of the Peri-formaldehyde when the liquid was boiled in an open vessel, or Formochloral was used which stands open boiling. Sheering's tablets were tested in the machine, also the Lentz generator. But for the purpose, the open evaporator served all purposes when lime was added to the evaporating liquid. No experiment gave a successful prevention of smut. The following tests will suffice to show the range of the work and the efficiency of dry fumigation with formaldehyde. The wheat used was made up of a mixture of three samples of very smutty wheat—furnished by Mr. Flitcraft, of Gardner, Mr. Hannan, of Mayville, and Professor Shepperd, of the College:

Exp. No. 1. Ten minutes fumigation in fumes from "Formochloral"—wheat grew normally. Crop showed 25 per cent. of smutted heads.

Exp. No. 2. Forty minutes fumigation as above—good growth from first—27 per cent. smutted heads.

Exp. No. 3. One hour and ten minutes fumigation—growth apparently as good as usual—31 per cent. smut.

Exp. No. 6. Two hours and ten minutes—Fumes from formaldehyde and lime water. The large barn room became unsuited for work. The grain came weak and thin. Actual smut showed 51 per cent. of smutted heads in the crop.

Exp. No. 8. Grain was placed in a sack and kept in a tight tank, fumigated twenty minutes by formaldehyde. Gas generated by Lentz apparatus. The steam from the machine was sufficient to moisten the grain considerably. Result : Slow, weak irregular growth. Wheat thin on the ground. Twenty-four per cent. of smutted heads in the crop.

Exp. No. 12. Same wheat dipped in the standard formalin solution, 45 gallons water, 1 pound of formaldehyde, for the preventing of smut. Heavy crop; no stinking smut.

Exp. No. 19. Same wheat untreated. Total amount of smutted heads in the crop was by actual count over a large area equal to 67 per cent.

The Chloride of Lime Treatment.—Many persons have advocated the use of chloride of lime for disinfecting seed grain. The method advocated by Mr. Huntoon, of Moorhead, was the addition of four pounds of chloride of lime to one hundred bushels of wheat—mixing

the same one month before seeding time. I have given the idea full trial. It has no merits, as is fully shown by the following tests, in which the same wheat was used as in Exp. No. 12, p. 22.

Exp. No. 9. March 25th placed wheat in a tight 52-gallon barrel. Used two pounds of chloride of lime (fresh) to two bushels of wheat. Kept barrel closed until April 27th, when wheat was seeded. Results: The germination record was as good as untreated seed and it also came up well in the field. The crops gave 44 per cent. of smutted heads.

Exp. No. 10. Same wheat; one pound of chloride of lime mixed with one peck of wheat, the whole boxed tight for one month and two days. Had difficulty in seeding this wheat, the lime had drawn much moisture from the air. It did not kill smut. The crop showed 57 per cent. of smutted heads of wheat.

A number of other treatments in which the lime was used in much less strengths but always of greater strengths than that recommended by Mr. Huntoon. All failed to lessen the amount of smut in the crop.

The Formaldehyde Treatment.—No treatment yet tested compares in cheapness of cost and success of prevention with the Formaldehyde "sprinkling and shoveling" method.

I give here the results of two practical farmers in determining the amount of the solution used in their work of treatment when done by the men at the farms. Mr. R. E. Fleming found after sprinkling and shoveling 1,800 pounds of wheat that the wheat then weighed 1,980 pounds. This reduced to figures shows that Mr. Flemming used at the rate of three-fourths gallons of solution per bushel of wheat. He raised a clean crop.

Mr. Geo. Osgood treated 2,090 bushels of wheat. Mr. Osgood "dipped in a large two handled flat bottomed box, handled by two men, and found that he used up 75 gallons of solution per one hundred bushels of wheat. Mr. Osgood's seed was "rejected" because of smut. He was able to offer one dollar per head for smutted wheat in the new crop. His men were unable to profit by his offer at harvest time. (Note Book No. 9, pp. 212-234.

THE RUSTING OF CEREALS.

Along with the weather studies upon the smutting of cereals the rust studies were considered. I have reached no further conclusions than those previously stated, i. e. that the most profitable studies upon rust will probably lie along the line of plant selection. (Book No. 9, pp. 445-260; also the work of 1898-1899 in field notes.)

THE DESTRUCTION OF WEEDS IN CEREAL GRAINS BY MEANS OF CHEMICAL SOLUTIONS SPRAYED UPON THE FOLIAGE.

During the spring of 1896 I undertook to kill weeds in grain by means of a spraying method. The results then attained discouraged further effort until the spring of 1899. During the spring, summer and autumn of this year 51 different spraying experiments have

been conducted, using several chemicals upon all the common weeds and cereals. The results have been most encouraging; and give promise that where weeds are too thick to pull they may be effctually eradicated without destroying the growing cereal crop. August 10th I made a preliminary report of the work to the Society for the Promotion of Agricultural Science—Columbus meeting, 1899. It is interesting to note that the work with Copper Sulphate has proved quite a marked success in the hands of several experimenters, working independently. In my own work with that substance I found one pound to four gallons of water and about 40 to 50 gallons per acre to give the best results. Other chemicals have been tried with marked success and give promise of much success. The detail of this work is too extensive for the purposes of this report and will be held until a full report may be made embracing recommendations as to methods. (Note Book No. 9, pp. 262.)

THE LIFE OF WEED SEEDS PLANTED AT DIFFERENT DEPTHS.

In this region of slight crop rotation it becomes a matter of much importance to determine the duration of the life of weed seeds in the soil when buried at known depths. The following test has been planned and started this autumn. The soil beds were prepared by removing a sod seven years standing, and placing the soil in fine garden condition. Seven kinds of seeds were planted, each in its own bed. In each bed six rows of seeds were planted, at depths of 1, 2, 3, 5, 7 and 10 inches respectively, beginning with the one inch seeding at the south end of the bed. The beds are so constructed as to be permanent, and the seeds are so placed as to be in normal soil condition, yet so that a part of them may be taken up at any time without disturbing the remainder. Beginning with the south bed, the seed beds contain seeds of

Capsella bursa-pastoris (Shepherd's Purse).
Thlaspi arvense (Penny Cress or French Weed).
Setaria viridis (Pigeon Grass).
Ambrosia trifida (Greater Rag Weed).
Brassica sinapistrum (Common Wild Mustard).
Polygonum Convolvulus (Wild Buckwheat).
Avena fatua (Wild Oats), respectively.

The rows were seeded 12, 15, 21 and 24 inches apart, so as to allow growth and work in the rows without disturbing, the narrowest spaced rows on the south.

The seeds were not placed in the ground until October 21st, when it was thought they would remain ungerminated until spring. But we were deceived, a part of them continued to come up until November 25th. On that date *Thlaspi* showed twenty-five growths from the one inch planting.

Avena: 1 inch seeding, 27 plants. 2 inch seeding, 16 plants. 3 inch seeding, 6 plants.

Brassica: At 1 inch seeding, 435 plants. At 2 inch seeding, 300 plants. At 3 inch seeding, 40 plants.

Elevator and Mill Studies.—It seemed important to have a clearer understanding of the relation of the milling and elevator interests to farming methods. To this end a number of mills were visited in the state and in Minnesota. Elevators were visited in practically every locality in the state. These studies gave much valuable information concerning the milling qualities of wheat, methods of handling, methods of milling, effects of smut, about weed seeds and weed distribution, wheat grading, etc. I wish here to thank the millers and elevator men for the uniform courtesies extended at all points.

As a general statement of the results of these visits it may be said (1) that stinking smut of wheat was found to be general in all the wheat growing communities of the state, and that the millers and elevator men are very anxious that the farmers should cease to grow it. I have found that by washing grain in distilled water, and then causing sedimentation of the water by means of a centrifuge, to be a very satisfactory means of detecting the presence of smut spores when present in such small quantities as to be otherwise impossible to detection. The amount of smut seems to vary in different regions, but I was unable to come to any general conclusion in this matter. (2) Elevator and mill men are quite uniform in their statements that the following weed seeds furnish the bulk of the screenings and dockage in the wheat of the state:

(1) "King Head" (*Ambrosia trifida*)—It also "cuts" grade because difficult to remove.
(2) Cockle, "rough," (*Lychnis Githago*)—It "cuts" grade.
(3) Cockle, "smooth," (*Saponaria Vaccaria*)—It "cuts" grade.
(4) Wild Buckwheat (*Ploygonum Convolvulus*).
(5) Pigeon Grass (*Setaria viridis* and *S. glanca*).
(6) Wild Oat (*Avena fatua*).

From my own experience, none of these weeds reduce the yield equal to the work of the pigeon grasses. Number three is at present the greatest menace, for it is a new weed in the farm work of the state, and is spreading rapidly. It is a great seed producing annual, the seeds of which take charge of the ground after the manner of common mustard, and is about as difficult to erradicate.

THE WILD OAT.

There are many varieties of awned oats in the state. Many tame oats are so hairy, barbed and awned that it is often difficult to determine whether wild or not from the seed. This season I observed the growth of twenty-seven tame varieties and also that of *Avena fatua*. I found that there are many tame oats of heavy yielding quality that in nearly all characters are wild in appearance. I found wild oats of size and weight which would compare favorably with most tame varieties. There was always one difference easily noticeable: *The wild oat grows an awn upon the secondary grain of the spikelet. No tame variety under observation bore an awn upon the secondary grain or flower.*

Studies were undertaken in crossing the wild and tame varieties, but I have nothing to report at this time.

B.—THE SELECTION OF POTATOES FOR SEED PURPOSES.

The work of testing the value of the large and the small potato from the same vine for seed purposes was continued for the sixth season, using five varieties of potatoes. The seed tubers were selected from last year's pedigreed crop. The results again affirm those of previous years. A mature bud from one vine thus appears to be as good as any other from same vine, when furnished with the same weight of tuber piece.

During the six seasons the continuous selection of a small potato from the same vine or strain, the work has not tended to "run out" the crop. The products from this sort of selection seems to have been each year neither better nor worse than those from the line of selection in which the biggest, best tuber was always taken. Soil and cultivation seems to be the main element in causing a variation in the standard of a potato strain. As there is always manifested a large element of variation in the different strains of a variety, the future work of the department upon the culture of the potato plant will be concerned in taking notes upon direct selection for improvement. The aim is not to get a good potato, but to learn by what means to proceed.

C.—BACTERIAL STUDIES.

One line of bacterial study was conducted throughout the year. The laboratory was also kept open for analysis of drinking waters, a number of which analysis were conducted. There have also been made a number of sputum analysis; and some microscopic examinations to determine the causes of diseases in farm animals.

The most important work of the year was the investigation undertaken in association with the Chemical Department upon the determination of the bacterial content of the soil. This work gave good results, but needs further investigation. (Note Book No. 10.)

One point of scientific interest was that involved in the question as to whether there are any bacteria, which may, as indicated by some investigators (Winogradsky and others), develop normally in a purely mineral food medium. The conclusions regarding this matter are recorded in a paper upon "The position of the fungi in the plant system as indicated by the work on the organisms of nitrification." (Centralblatt f. Bakt. Zweite. Abt. V Bd. No. 25.)

"The Duration of Bacterial Existence Under Trial Environments." —During nine years, the department has taken notes upon the vitality of various species of bacteria, when kept under known condiitions. The results of this work were presented before Section "G" of the American Association for the Advancement of Science, Columbus meeting, 1890. The paper has been printed in the Centralblatt fur Bakt. Zweit. Abt. VI Bd. No. 2. The most important features of the

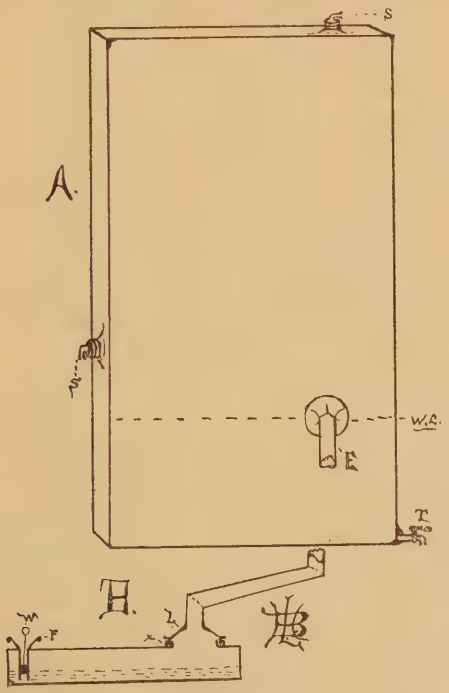
work, from a practical standpoint, is the fixing of the fact of the wonderfully lasting vitality of the Bacillus of typhoid fever.

D.—MISCELLANEOUS STUDIES.

Distilled Water for Drinking Purposes. — Though perhaps, not worse than the average quality of the water supply in many other localities in the great plains, it is certain that much sickness and ill health upon the farms is due to the water supply. In general the water supplies of the state have been found to be far too heavily laden with mineral matters, and often contaminated with germs of disease. Indeed, it may be said that from this latter cause alone the water of any surface supply is unsafe. It is now generally agreed among physicians that the use of distilled water for drinking purposes would save from much disease and ill health.

There is no cheap distilling apparatus on the market suited to use upon the kitchen stove, none which can produce sufficient distilled water for the use of a family. I have therefore undertaken to plan a distilling apparatus which any tinsmith can construct at small cost, and one which will provide a large amount of distilled water.

The following described apparatus can be constructed at a cost of five to ten dollars. Upon the ordinary kitchen stove it will furnish



FIGRUE 2.

from seven to twenty gallons of water per week, according to the constancy of the fire. One has been in use in my home one year and three months, and has furnished a constant supply of the pure water.

Directions for Construction.—The parts to be constructed are shown in figure 2, the condenser "A" and the evaporator "B." Make an inclosed evaporator pan, "B," large enough to cover two holes of a kitchen stove or range, say 21½ inches by 9¾ inches by 4 inches, for a No. 9 stove. It is inclosed at all points except only the filling funnel (F) and the steam escape tube (L). The funnel tube is three fourths inches in diameter, is soldered into the top of the pan, and reaches within one-eighth of an inch of the bottom—to prevent escape of steam. The steam tube (L) is made in the form of a lid 7 inches wide and fits closely into a double rim (X) which prevents the escape of the steam and allows return drippings from the tube to run back into the evaporator through a small perforation. At (W) is a wire loop attached to a cork float showing the water content of the evaporator. If lid (L) is placed in the pan the same distance from the end as from the sides it will be possible to turn the evaporator either across or lengthwise of the stove. The evaporator may be made either of galvanized iron or tinned copper. The flat nature of this pan furnishes a good warming shelf or rest; hence is not a waste of space when upon the stove. Tube (L) of the pan should be 1½ inches in diameter and so made as to slide into tube (E) of the condenser. (A) is a surface, air condenser and water reservoir. It rests upon small brackets upon the wall back of the stove and above the level of the evaporator.

Make the condenser (A) of bright tin into the form of a tight flat box, three inches deep, four foot long and 27½ inches wide. Stock tin usually comes in sheets 20 inches by 28 inches. It can be made longer than four feet to advantage if there is sufficient wall space. (E) is the tube through which steam enters. (T) is a faucet for drawing off the water. (WL) show water line, about five gallons, the condenser will hold at one time. (S) shows two small stream escapes made by fitting tin screw caps over one-fourth inch openings into the condenser. The screw caps are perforated by one-fourth inch holes over which are small bent tubes. These may be so turned as to direct escaping steam away from the wall and prevent the entrance of dust into the condenser.

Figure 3 shows a very effective condenser. It consists of a tin cylinder 7 feet long and 4½ inches in diameter, having a sliding connection (S) for catching the steam from an ordinary tea kettle. This tube slides into a fixed tube so there is no return drop water. This simple distill should be made of bright tin, and costs something less than two dollars to make. At (E) is a small elbow steam escape. The condenser is constructed to hang from a hook (C) in the ceiling by a string or wire connection (AN). When kept in constant operation this still will easily furnish 1 to 3 gallons of water per day. If the kitchen ceiling is sufficiently high the cylinder may be made

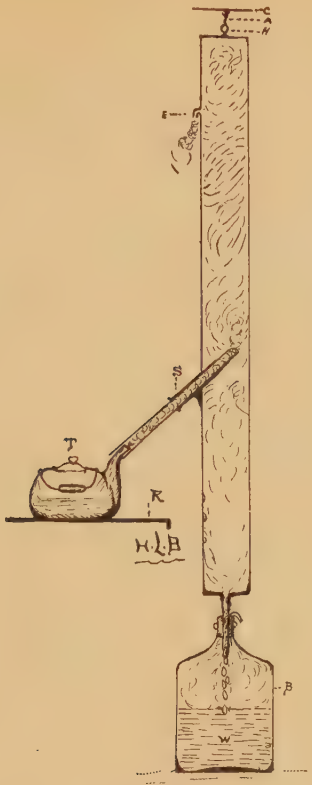


FIGURE 3.

longer to advantage. As it swings behind the stove or range out of the way when not in use, this is a very convenient form of condenser. In making these condensers all seams should be soldered on the outside to prevent the contact of the solder with the drinking water.

THE DEVELOPMENT OF THE BUDS OF THE WILD PLUM (PRUNUS AMERICANA), BY LAWRENCE R. WALDRON.

For those who are interested in the culture of fruits, especially the smaller or garden varieties, it would be an important matter if it were possible to determine the causes underlying the formation of flower buds or fruit buds upon the branches. It is seldom that fruit trees and fruit shrubbery bear fruit regularly every year. Some years the buds are all of a foliage variety or but few if any fruit buds are formed. In order to determine this point it seems quite necessary that a careful study of development of some of the different types of buds should be undertaken. During the school year of 1898 and

1899, Mr. Lawrence Waldron undertook the study of the development of the buds of the wild plum tree. The results accomplished are of such interest that I feel certain they will be of value as a basis for further study and I therefore append an extract of his graduation thesis. The work begun by Mr. Waldron opens up the way for a consideration of the possible causes underlying the setting of fruit buds. The work is also of interest in the fact that, though unknown at the time, Professor E. S. Goff, of the Wisconsin Experiment Station, was also conducting the same study upon the flowers in the cherry, plum, apple and pear. Professor Goff and Mr. Waldron, working separately, have reached essentially the same point in the development of the work and have attained to essentially the same conclusions.

THE EXTRACT.

The work embodied in this paper was first suggested by Professor C. B. Waldron. The plan, enlarged by Professor Bolley, was to gather a number of buds of Prunus Americana each month during each year from a few trees and by a series of freehand sections study, primarily, the time and manner of differentiation of leaf and flower buds, and the influence affecting the formation of flower buds; also a study of the reserve materials and other features which might come into prominence as the work proceeded. Certain phases of the work should be continued at some future time as no very definite results could be arrived at in the time devoted to it.

The freehand method was employed because of the great number of buds studied. In the growing point of a June bud, the dermatogen was easily distinguished. The next three layers were sharply marked off, the third one less than the outer, thus defining the periblem.

Arrangement of Leaves Upon the Growing Point.—While the origin of the members of the bud under consideration is the same, yet, we do not consider one member as developed first and that the other members were modifications of that one, but that the different parts were adapted for use little by little. It does not make matters of plant morphology much more clear to say that a stamen is a modified leaf.

Both leaves and scales have the same vernation, both being imbricated, lapped over each other like shingles. In the case of the leaves a tendency is shown toward obvolute vernation though this is due to the shape of the bud and probably to the mechanical influence of the midrib. The phyllotaxy of the bud scales is two-fifths.

Symmetry of the Bud.—The leaf buds are both radially and bilaterally symmetrical. They are flattened dorsiventrally when formed upon primary shoots of one season's growth. The amount of flattening seems to depend upon the rapidity of growth, the more rapid the growth, the flatter and more triangular in outline they become. Leaf buds formed upon secondary shoots and terminal buds upon all shoots approach the radially symmetrical type. The difference

in the flatness and in the roundness of the bud is due to the difference in pressure exerted by the petiole upon the forming bud. The leaves in the primary shoots are more vigorous than are the leaves of the secondary and so the petiole of the leaf would be less easily pushed aside by the forming bud, and the bud would consequently take the flatter form. The terminal buds have no interference in growth. As the flower buds are formed upon secondary shoots they would tend to be radially symmetrical for the reasons given in the case of the leaf buds.

Comparative Development of the Buds of a Branchlet.—To determine if there were any relative difference in the time of development of the buds of one branchlet, a typical branchlet was selected, gathered on February 15, bearing from base to tip, ten buds. The branchlet was moderately dwarf in character as indicated by the fact of its having six flowing buds. At each of the fifth, seventh and eighth nodes, two buds were present, one flowering and one leaf bud. A careful examination of similar sections from each of the buds showed no apparent difference in the state of development. While the buds developed in acropetal succession, that is, from base upward, it is probable that the difference in time of formation was so slight that at the time of stoppage of growth in the fall, they had all reached the same phase of growth.

Methods of Branching.—Little is to be said regarding the branching of the leaf and flower parts. The flowers grow in umbel-like clusters from scaly buds. The number of flowers in each cluster is four. There may be less when the bud is fully developed, but this is due to the death of one or more of the flowers in the bud. The vegetation shoots branch alternately. The arrangement is the same as that of the bud scales, two-fifths. In the raceme of *Prumus demissa,* the flowers have no regular arrangement upon the axis.

Study of Reserve Materials.—According to Sachs, (Phys. of Plants, pp. 66, 175, 178) calcium oxalate is always to be considered as a waste product within the tissues of the growing plant. "The fact that it is found in growing cells does not alter the fact that it is a useless secretion." It is found in the bud scales from the very first, almost, crystals being found in the second scale from the apical point. In a July bud, the crystals were about as plentiful in the bud scales as in the month previous. No crystals were in the three or four sets of scales immediately surrounding the growing point. The crystals were thickest in the outer set of scales, the central portion of such a scale being closely set with them. The outer scale of one bud contained over fifty crystals that showed in one long section of the scale. The entire scale would thus contain innumerable crystals of the oxalate. In the bud scales, the crystals in the outer sets of scales contained much larger crystals, thus showing continuous accretions to them. The crystals are also numerous in the body of the bud below the meristematic tissue. In a long section of the stem taken from the soft and growing shoot, but very few of the crystals were found. Those present were very small. A

comparison of two sections, one from a very vigorous stem and the other from a dwarf stem, seemed to indicate that the oxalate is deposited in a much greater quantity in the dwarf than in the vigorous bud but this was, perhaps, an exception to the general rule.

By August, the crystals in the outer scales are far too large to be confined to a single cell. The effect is to tear apart the layers of the cells.

The number of crystals found in the scales of flower buds of this month was very much less than the number found in the scales of leaf buds of the same month. This is due to the fact that quite a space of the bud is devoted to the flower parts which, being meristematic, have no recognizable crystals, and to the fact that the scales themselves are much thinner than those in the leaf bud. Even in the outer set of scales, where the crystals are so abundant in the leaf buds, the number and size both seem to be less.

The number of crystals in the lignified portions of the bud scales is less than the unlignified portion of the same scales immediately beneath. Accretions ceased to be made at the time of the complete lignification of the tissues, thus indicating that the lignified portion is a permanent or dead tissue. Because of the smallness of the crystals the layers of the cells of the lignified portion are not torn apart. While the number of crystals appears to be less in the bud scales of the flowering branches, yet this does not hinder the bud scales from splitting longitudinally below the lignified portion. This doubles, in effect, the number of scales surrounding the bud and by producing double the number of air spaces secures perhaps a possible aid for the protection of buds against cold. During the winter months no perceptible change takes place in the number or position of the crystals.

From the fact that there is so much of the oxalate present in the scales almost from the first and that a relatively larger amount is found in the scales than in the leaves of the same age, if the oxalate is a waste product, it appears that the work that the scale has to do is decided from the beginning as the oxalate is cast off in the scales. It is possible that it is of real value there in the scales.

Lignin.—Almost as soon as the young bud is exposed in the axil of the leaf, lignification begins, the scales grow woody and hard. In a bud collected in June, the tips of the outer set of scales showed the lignin reaction. Buds gathered a month later showed three or four sets of scales partially lignified. In the two outer sets, the lignified portion was quite sharply marked off from the unlignified portion but not so sharpely as in later formations. August buds showed further lignification. In some of the buds of this month, seven or eight sets of scales showed more or less lignification. In September buds, the limit of lignification was indicated by a sharp demarkation between the lignified and cellulose portion. In the buds gathered in October, the lignified portion was yet more sharply marked off and the cellulose portion, and here showed the first extended splitting up

into two layers. No further change of moment was observed in regard to lignin except that it became somewhat darker in color as the season advanced.

Cutin.—The buds gathered on June 12th, showed heavy cutinization, cork formation on the outer surface of the bud scales, especially upon the outer scales (Fig. 7). This is added to but little during the later months. The use of the cutin is obviously protection.

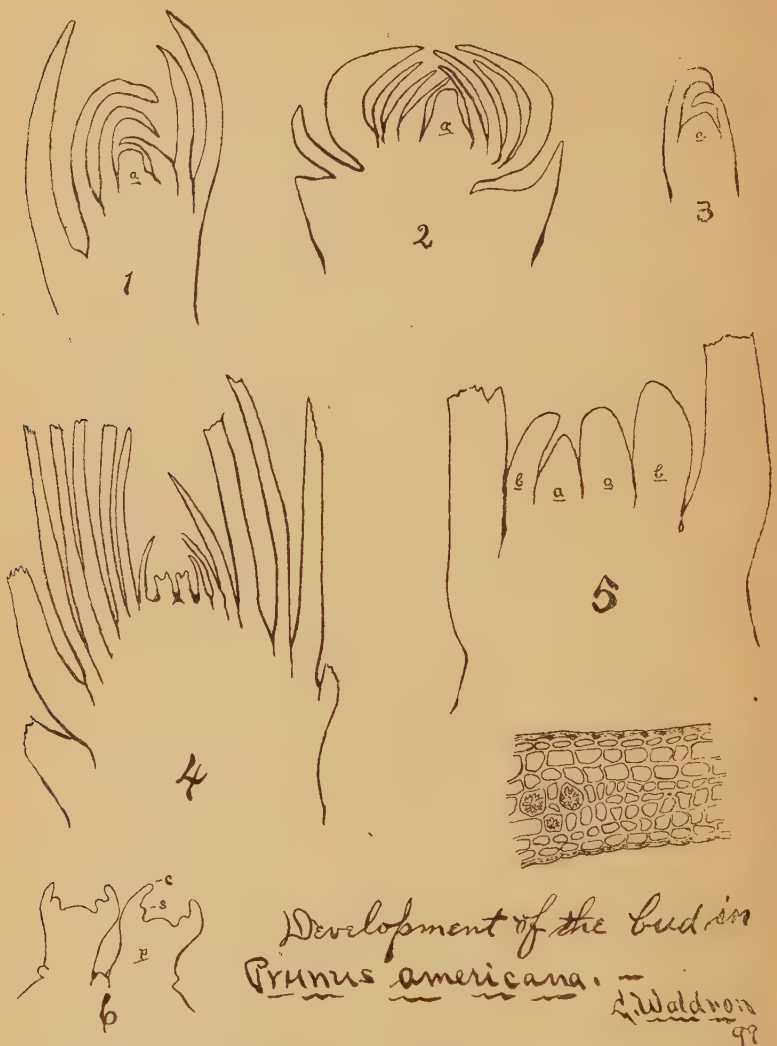
Study of Appendages and Outgrowths.—Considering the bud solely in regard to its functions, the bud scales may be regarded as appendages as they serve only a passive use in the plant.

Outgrowths.—The hairs of the bud are of one kind, unicellular and unbranched. These originate from the epidermis of the scales and leaves, each hair being derived from one cell. Each hair communicates to the base of its cell as is seen in optical section. They occur generally only upon the ventral surface of the scale and of the leaf. In buds gathered in July, a few hairs were seen upon the dorsal surface of the scale but the presence of them here is rare. They develop very early in the age of the scale but do not form a felt until as late as July. In this month the average length of the hairs is 140 microns. The hairs reach their full development in August. When first formed they are composed entirely of cellulose, but in a few weeks lignification begins, extending from the apex downwards. Those upon the young leaves show a much thinner wall and a consequent larger amount of protoplasm than do the hairs of approximately the same age upon the scales.

The function of the hairs upon the scales is probably protection against cold, while those upon the leaf may protect against too rapid evaporation. Air currents would be prevented from reaching to the surface of the leaves when they were once expanded.

Morphology of the Pistils and Stamens.—The freehand sections show quite well the positions of the stamens and pistils. By the 12th of August the flower bud had developed so that the young flowers showed clearly (Fig. 4). In a bud gathered July 12th (Fig. 5) the flowers are seen to be much less developed than those in Fig. 4. This figure is from a higher magnification than other sketches; (a, a) indicate the future flowers. Fig 6 represents the flowers from a bud gathered August 12. At this stage the stamens are not differentiated into anthers and filiaments and appear as protuberances on the base of the calyx. The young flower is now 400 microns long and 275 microns wide. The pistil is 129 microns long and the stamens 67 microns long.

In October the pistil shows first indication of a cleft which will be eventually filled by the ovule and the placenta. The stamens show differentiation into filiaments and anthers, and calyx and corolla parts become quite distinct. The flower is 480 microns long. The stamens 100 microns long. The stamen arising from the calyx can be seen to take the greater part of the vascular bundle, the perianth receiving the remainder.



From October to November the buds changed but little. The buds measured, which were gathered in November, from 525 microns to 550 microns long. The cleft in the pistil becomes more distinct at this time. The buds undergo no change during the winter months. This is interesting, in the fact that the organic parts become differentiated before winter.

In the spring rapid enlargement of all parts takes place; the cleft in the pistil widens, the ovule begins growth gradually curving over upon itself, the filiaments lengthen, and the corolla develops and soon becomes longer than the calyx.

Differentiation of Leaf and Flower Buds.—Until the middle of July, bud scales are being developed from the bud and hence no diffentiation of leaf and flower buds can be detected. From the middle of July to the middle of August, seems to be the maximum time in which differentiation into leaf and flower parts takes place. Of sections taken from buds gathered in September and later, a larger proportion were flower buds than were those gathered earlier. From this it would appear that the time of differentiation extends to a later time than the middle of August. The first indication of the formation of flower buds is a simple cleft of the growing point (Fig. 5). Each part immediately begins rapid growth, and soon stamens, pistils, and perianth may be distinguished as protuberances. Further development is as described.

Conditions Affecting the Formations of Flower Buds.—It was the original intention to give this subject predominence, but the preliminary studies here recorded occupied the greater portion of my available time. The subject is a wide one of vast importance and needs much investigation.

A few facts have been determined. A large quantity of reserve material must be present if flower buds are to be formed. (Sorauer Phys. of Plants, pp. 222.) Certain methods of pruning are known to affect materially the formation of flower buds. A short thick shoot will produce a much higher percentage of flower buds than leaf buds and vice versa.

Reasoning from these facts we see that during the life of the bud there is a critical period in which the future nature of the bud is determined. The problem to be solved is to determine the exact nature and condition of the factors modifying the bud at this period. These determining factors are various and among them may be mentioned; an inherited tendency to produce vegetative or flowering shoots, which may distinguish a strain, any artificial change in the tree which tends to change the amount of reserve food to be stored within, such as top or root pruning, twisting or notching the shoots, etc., the influence of climate, and other known and unknown factors. The nature and extent of influences affecting the formation of the leaf and flower buds have not been ascertained by any precise set of scientific experiments, but they have come rather as the "heritage of the ages." (Sorauer loc. cit.)

As planned at first, four trees were selected in May, 1898, one of which had no fruit, one full fruited, one selected to determine the effect of root pruning, a similar one to determine the effect of top pruning, and a fourth tree from which two limbs were selected, one having no fruit and one full fruited, to determine to some extent the conditions which govern the number of flower buds.

The notes taken in connection with these experiments have been preserved for future use and the following record is made: In the top pruned tree, a count was made of the leaf and flower buds from a branch gathered in December and of a total of 35 buds, 57 per

cent. of these were flower buds. Of the buds found on secondary branches 66 2-3 per cent. were flower buds from a total of 24 buds. On the tree from which two limbs were selected, one full fruited and the other having little fruit, a branch of each was taken to determine the proportion of flower buds. The work was done April 17th, 1899, and resulted as follows: From the limb having no fruit the year before, the number of buds counted was 70, of which 38 per cent. were flower buds. From the full fruited limb the number counted was 78, of which 46 per cent. were flower buds. On May 11th, 1899, the full fruited limb of the year before showed a much larger number of flower buds than did the limb having no fruit. The small number of trees examined forbid the drawing of conclusions.

Methods Employed.—About 175 mounts were made representing about 800 individual sections. By far the greater part of these were cut freehand with the razor and but comparatively few were stained. It was found that treatment of the sections with hydrochloric acid previous to staining with chlor-iodide of zinc produced much more marked results than the use of the chlor-iodide of zinc alone.

The microtome material was fixed in two per cent. chromic acid with a trace of acetic acid, cleared in chloroform and embedded in paraffine melting at 52 degrees. The material was cut with a Bausch & Lomb laboratory microtome set to cut eight and ten microns thick. The sections were treated by Strasburger's method for the removal of paraffine and were strained with borax carmine, methelene blue and carbol-fuchsin. The latter seemed to give the best results.

Summary.—In order to obtain a clear idea of the value of the organs discussed, it is necessary to dismiss the erroneous idea that stamens, pistils and scales are all modified foliage leaves. In place of this we must substitute the idea that all of these organs are modified portions of the tissue of the shoot axis.

The symmetry of the bud is mainly determined by mechanical influences. The buds of one branchlet attain approximately the same stage of advancement when growth is checked in the fall.

The number of flowers starting in one bud is four. This number is often lessened by one or more dying later.

Calcium oxalate is found in abundance in the bud scales in nearly all stages of their growth. It is found in much less abundance in the young leaves and in the young portions of the stem and not at all in the flower parts in quantity that I could demonstrate. It tears the bud scales into two layers, leaving an air space between, which probably aids in protection from cold by furnishing a greater number of air spaces. The number of crystals seems to be less in the bud scales of the flower bud than in the bud scales of the leaf bud.

Lignin commences forming very early in the life of the bud and by September the lignified portion is sharply marked off from the cellulose portion.

A thick layer of cutin is formed upon the dorsal surface of the scale soon after formation.

The walls of the hairs of the scales are much thicker than in those on the leaves of corresponding age.

The organic parts of the flower are formed before winter; the ovule is formed in the spring.

The most important time of differentiation of leaf and flower buds appears to be from the middle of July to the middle of August. There is evidence to show that differentation may take place later.

No deduction from this work can be drawn concerning the factors affecting the formation of flower buds.

June, 1899. L. R. WALDRON.

WEEDS, SEEDS AND NATIVE PLANTS.

During the year 400 new plant specimens have been added to the herbarium, and there has been prepared a large collection of weed seeds. Of the seeds there are now cleaned and bottled over one hundred species in amounts of an ounce or more. These are of much reference value.

SEED TESTING.

The demand for seed examination and seed testing is of the nature of a continuous growth. It is a line of work in which we can be of much aid to the people of the state. I hope during the coming year to place the work of the department, in this line, upon a systematic basis.

Assistance.—My assistance has been such, during the past school year, that I have been relieved of many of the minor features of the College work, with the result, that I have been able to give more close attention to the work of the Station.

Respectfully submitted,

H. L. BOLLEY,
Botanist.

AGRICULTURAL DEPARTMENT.

To Director J. H. Worst:

Sir: The work in this department of the Experiment Station has been continued in lines heretofore reported upon with only minor changes in details. The improvement in varieties of seed grain by selection has been given more attention, and the best one of the 225 collected varieties of wheat has been sent out to the farmers of the state. The seed has been distributed by sale in quantities of five bushels or less per man. Fifty-nine bushels of seed wheat was thus sent to sixteen different men in the state, which together with wheat distributed during other years has put good fife seed into many districts of North Dakota.

The present grain storing capacity of the station limits the quantity of surplus seed wheat which can be stored to about 150 bushels per year. That quantity has been stored and cleaned to be sent out this season. Other strains which have been developed by breeding and selection are coming on and will produce still better seed for future distribution. It is hoped that this work will be allowed to extend to other classes of farm crops, as it promises much good in tangible and direct results for the state.

The study of Bromus inermis(Austrian Brome grass) has been continued in an attempt to obtain facts which will answer the numerous questions now being asked relative to this new grass. Among these trials I may mention studies of manuring, disking, plowing over the sod, annual seeding and seeding with a grain drill as compared with sowing the seed broadcast and harrowing it in. Trials have also been made of scattering the seed upon native sod to see whether it will succeed in making a stand.

The value of brome hay as feed for horses has also been tried in comparison with timothy hay. A trial of threshed brome hay compared with timothy hay for cattle has also been inaugurated and is now in progress.

Other practical points studied are the value of old brome grass sod for pasture and the method and cost of threshing for seed. A trial of the grass for lawn purposes, where no artificial water supply is available has given very promising results.

The trial and introduction of this grass in the various districts of the state has been aided by the distribution of two hundred nineteen, pound samples, to two hundred nineteen persons, in twenty-seven counties in the state since my last annual report. The grass is now growing in every county of the state, while a number of samples have been placed in some counties.

During the past year sufficient seed was produced upon the farm to supply all reasonable demands for the one-pound trial packages, to supply the Station's needs for field sowing and for experimental purposes, and 2,000 pounds to be distributed by sale in lots of 50 pounds or less at the market price. Six hundred eighty-five pounds of it has been sold to fourteen farmers in the state.

The root system of brome grass at different ages has also constituted an interesting and instructive study.

Sixty-three varieties of wheat were grown upon the trial grounds during the past season. A few of them were wheats advertised for this district, and some were varieties brought to America by the United States Department of Agriculture, coming chiefly from Russia. Several varieties which have been bred up by this Station and by the Minnesota Station were also given a trial in the uniform plots of ground used for the purpose. The latter varieties are showing splendid results and will furnish good kinds to be placed in the hands of growers, later.

Thickness of seeding wheat was given another trial, having been planted at eight different rates per acre, ranging from very thick to very thin.

Twenty-six varieties of corn were grown in comparative trial and close observations were made and recorded upon the stages of maturity at different dates during the latter part of the season, beginning at the time when the danger from early frosts will be imminent. Yields per acre of grain and fodder were recorded, together with the amount of moisture in each, at the time when it was necessary to husk and stack it. The study of the thickness of planting corn was extended, twenty-four different thicknesses having been grown. The depth of planting corn was also given attention, trials of six different depths having been made.

Forty varieties of potatoes were grown for comparative study. Potatoes were grown at twelve thicknesses to learn the results. Six depths of planting potatoes were also tried.

Small plots of mangels were grown in order that their yield might be determined.

A number of new varieties of oats were grown and further trial made with kinds which have been grown for one or two years before. The entire number grown upon the variety trial plots was thirty-eight.

Twenty-five varieties of barley were grown in comparison, including some new kinds and several which have been grown less than five years in this trial.

Spelt from seed obtained near Bismarck, N. D., was grown in comparison with some which was introduced by the United States Department of Agriculture direct from Russia, and some which was brought from the same country one year ago and grown here last season.

Three plots giving trials with flax and wheat mixed were grown

and the yields recorded. Flax was sown at nine different rates or thicknesses per acre.

Flax from imported samples and from two different local sources, making four kinds in all, was grown in a comparative trial.

Six varieties of buckwheat were grown, one of which proved to be very promising. It was introduced by the United States Department of Agriculture.

Six varieties of field beans were grown and the results duly recorded. Three plots of beans planted at different thicknesses were grown. Fifteen varieties of millet were grown in a comparative trial. Several of these were from seed introduced by the United States Department of Agriculture, while several others were of varieties advertised in this state.

Trials with rape for sheep and milk cows were made.

Four bulletins, numbers 36, 38, 39 and 40, were published by this department during the past year.

Bulletin No. 36 gives the result of an interesting and extended study of the root systems of crops. In addition to the root study a complete mechanical analysis of the soil was made. The study of root systems of plants was continued during the past season, brome grass, timothy, native prairie sod, flax, sugar beets and potatoes having received attention. I regard this study important and one which aids in many considerations of plant life. That study will need some further attention to determine the regularity with which the roots of important farm crops descend, to the depths noted, and form the kinds of root systems which they had during the season which was reported upon in bulletin No. 36. If a similar study could be made of wheat and brome grass rooting systems upon other classes of soils in this state, I believe valuable information would be obtained.

Bulletin No. 38 contains a discussion of the results obtained from cultivation trials and from moisture and temperature studies. Following is a brief summary of its contents:

SUMMARY.

1. Fall plowed land gave one bushel per acre heavier yield than spring plowing, as an average for seven years trial.

2. Wheat sown in drills and cultivated gave a yield of ten bushels and twelve pounds less per acre than wheat sown in the ordinary way.

3. Ground plowed with the Secretary disk gang plow yielded 50 pounds less per acre than that plowed with an ordinary moldboard plow.

4. Sub-soiled land gave an increase of 54 pounds per acre but at greater cost, making the net profits 42 cents less per acre upon sub-soiled land.

5. Harrowing land immediately after plowing gave an increase of 39 pounds per acre in yield and an increase in net profit of 25 cents per acre.

6. Land sub-surfaced packed gave one bushel and six pounds

greater yield than land not packed and 61 cents greater net profit per acre.

7. Deep plowing gave 43 pounds greater yield per acre than shallow, and 37 cents greater net profit.

8. Rolling and harrowing land after seeding gave an increase of three bushels and 11 pounds per acre in yield, and $1.25 in net profit as a result of a single trial in the season of 1898.

9. Harrowing wheat one week after seeding caused an increase in yield of two bushels and one pound and an increase in net profit of 72 cents per acre.

Bulletin No. 39 contains a statement of the results obtained from the trials made with field crops. Following is a brief summary of the results:

1. Of the 39 varieties of wheat tested in 1898, the two standing highest in grade and yield were Selected Haynes' Blue Stem (No. 214), and Selected Rysting's Fife (No. 215). Both varieties were originated from single plants by careful selection.

2. As an average result from five years' trial, Bolton's Blue Stem (No. 146), gave the highest average yield.

3. As an average result from seven years' trial, Experiment Station Fife 66 stands first in both yield and grade.

4. The data which have been obtained on the effect of changing seed wheat, indicates that nothing is gained by a change of seed if a change is the only thing accomplished. If a better variety, or a better strain of the same variety can be obtained, the change of seed may be well worth the cost.

5. Five and one-half pecks of seed wheat per acre gave the largest average yield for the several trials.

6. The depth of sowing wheat in 1898 had but slight effect upon the yield. Two to three inches seem to be the best depth.

7. Tartarian oats (No. 26) stands at the head as the largest yielder in a five years' test.

8. The thickness of sowing oats, from five to ten pecks per acre respectively, had very little effect upon the yield of grain.

9. Oats sown three to four inches deep gave the best average yields last season.

10. As the result of four years' trials, Mansury barley (No. 7) has given the largest yield.

11. The results of a single trial favor three inches as the depth for sowing barley.

12. Trials with spelt indicate that it is equal to barley in yield, and its chemical analysis shows that it is equal to barly or oats as a feed for stock. It is worthy of a trial by the farmers of our state.

13. Rye has not proved a profitable crop at this Station.

14. Early varieties of buckwheat may be grown with profit in the eastern part of North Dakota.

15. The season of 1898 was too short for the full maturing of even the earliest varieties of corn. Gehu, Will's Acme, Will's Da-

kota, Mercer, Smut Nose and Northwestern Dent are among the best varieties for this locality.

16. None of the varieties of kaffir corn have matured at this Station in any season. It cannot compete with Indian corn as the varieties now stand.

17. Corn sown broadcast gave a little lighter yield than that sown in six inch drills. The largest yield both of grain and fodder was obtained from the corn planted in drills 24 inches apart.

18. Corn planted in rows three and one-half feet apart and cultivated, gave the greatest yield of fodder and ears when planted one kernel in a hill and six inches apart in the row.

19. Corn planted more than five inches deep came up poorly. That planted two to four inches deep gave the best yield in 1898.

20. Only the earliest varieties of potatoes ripened in 1898. The results of a single trial, place Early Andes at the head in yield and equal to Early Ohio in quality and earliness of maturity.

21. Early potatoes planted in hills ten inches apart with the rows three and one-third feet apart gave the largest yield recorded last season. Doubling the amount of seed planted in a hill did not increase the yield but seemed to increase the percentage of small and scabby potatoes.

22. A single trial indicates that four to five inches is the best depth to plant potatoes in this soil and climate.

23. The results from a six years' trial in rotation of crops, show that it does not pay to raise wheat continuously. By rotating wheat with cultivated crops, larger yields are obtained and a better quality of wheat.

24. Land which produced three crops of wheat and one cultivated crop in a period of four years, gave almost as much wheat and more profitable returns than did the land which produced four crops of wheat in succession.

Bulletin No. 40 contains the results of experiments and observations made upon the cultivated grasses and forage crops.

In accounting for my time I will perhaps be justified in stating that the answering of 170 letters of inquiry upon specific farm topics by means of personal letters has required a considerable portion of time and the expenditure of some energy.

A. M. Ten Eyck, M. S., has acted as assistant agriculturist during the past year. I wish hereby to make the public recognition which is due him in filling that position.

My thanks are due Mr. H. M. Ash for efficient and painstaking work in the discharge of the duties assigned to him during the past season.

Respectfully submitted,

J. H. SHEPPERD,
Agriculturist.

DEPARTMENT OF HORTICULTURE AND FORESTRY.

To J. H. Worst, Director:

The work in this department was for the most part a continuation of the experiments outlined and started in 1898.

The same plots were used for trials with the different fertilizers and these were applied in the same order and amount as for the previous season.

A condensed record of a part of the work done along these lines will be found in bulletin No. 42 issued in December, 1899. The exact results shown in the different yields cannot be given here, but the following, taken from the bulletin is a general summary of the work:

In the spring of 1898 a series of experiments was inaugurated to determine the influence of different classes of fertilizers upon different garden vegetables. The points to be noted were:

First—The influence upon total yield.

Second—The influence upon quality and habit.

Third—The influence upon maturity or time or ripening.

Fourth—The influence of different elements at different stages of the plant's growth.

Fifth—The effect that the different fertilizing elements, applied in the early stages of growth, might have upon the subsequent development of the plant, and

Sixth—The relative value of the different animal manures, applied to the same problems as above.

This work was continued through the season of '98 and '99. The report now presented touches only upon points one and three, and the results under these heads are largely negative.

Under the heads four, five and six we have complete notes of some positive and rather striking results, the publication of which is deferred until they can be confirmed by another season's trial, and also until fuller photographic records can be obtained.

The most striking part of the experiments is the apparent indifference of the soil to any and all fertilizers.

The great uniformity of the soil in the Red River Valley would render any experiments affecting the total yield of considerable importance, but so far all we can say is that the manner in which the soil is handled has far more to do with the returns than a heavy application of the best fertilizers. The work so far would indicate that the time and depth of plowing, protection of the soil in winter, manner of cultivating, time of seeding, transplanting, etc., are lines

offering a better opening for experimentation than the one here recorded.

It was found that the larger sorts of onions transplanting gives much the best results, and the gain is considerable, even with the ordinary sorts.

The Gibralter makes a better showing than the Prizetaker, both in size and quality.

The difference in behavior between certain varieties of the same vegetable may be accounted for in some instances, as in beets, on the basis of different habits of growth; in other cases no explanation seems possible.

The publication of the notes under points four, five and six will furnish material having a general value, and not confined alone to the Red River Valley.

The general work with fertilizers will be discontinued and only special lines of the work carried on, such as the result of different elements when applied at different stages of growth, and the effect of an early application upon the subsequent development of the plant.

The results obtained show that a single trial, upon rich soil of any given fertilizer is no test of its value. Even when applied to different varieties of lettuce, cabbage, etc., the results are conflicting and often contradictory.

The following varieties of vegetables make the best showing:

Beets—Edmond's and Wilson's Improved.

Onions—Gibralter for size and early market and Australian for good keeping qualities.

Cucumbers—White Wonder and Hill's Forcing.

Cabbage—Early Summer, Washington Wakefield and Early Spring for early, Succession and Marblehead Mammoth for the main crop.

Lettuce—Dwarf White Heart, Prizehead, Thickhead Yellow and Early Curled Silisia.

Tomatoes—Early Minnesota and Early Michigan.

Beans—Valentine Wax, New Stringless.

Radish—Cincinnati Market, Earliest White.

Peas—Advance, Gradus.

Carrots—Model and Short Horn.

Sweet Corn—Early Sheffield, Banana and Russia No. 2799.

Popcorn—Mapledale Prolific.

Of small fruits all of the thirty varieties of currants and gooseberries grew well and most yielded full crops of fruit. The Cuthbert raspberry yielded heavily and the Turner also did well. The De-Sota plum trees produced to their full capacity and some of the wild types were hardly behind them in quality or productiveness. Nearly half of the wild plum trees were found dead in the spring; the roots were entirely killed. The cause was not determined, but was wholly unlooked for, as the trees had always been exceptionally vigorous. These trees were grown from pits brought from Iowa.

Trees of the same species taken from native thickets suffered no injury. This may have been accidental, but probably was not, as the Iowa stock suffered but little where it was well protected.

All of the apples made a good growth and contrary to our usual experience, did not suffer from blight.

The Moore's Early was the only grape to ripen its fruit and the season was exceptionally favorable.

FORESTRY.

Until the past season we have always recommended the White Ash as the most promising tree for groves and timber belts. During the last year it has shown itself subject to very serious attacks from borers and from a bark beetle that appeared in such numbers as to destroy or cripple nearly all the trees. The bark beetle (Scolytidæ sp; indt.) work just beneath the bark and girdles the tree in numerous places, leaving only a small strip on the south side. There is no practical remedy and judging from the present outlook the tree must be abandoned.

In Bulletin No. 41 issued by this department in September under the head of "Hints on Ornamental Planting," the value of different trees for general planting is discussed.

The elm for general planting doubtless ranks first, but failure is sure to result in the cultivation of this tree unless one is very particular to employ exactly the proper methods at the start. In the bulletin referred to full cultural directions are given for this and other forest trees.

INJURIOUS INSECTS.

During the month of June, I spent considerable time in the vicinity of New Rockford and also at Rolla, on account of the appearance of the Rocky Mountain locust at these places.

Plowing was begun in most of the stubble fields while hatching was still in progress and the young were too small to make their escape. In most fields the work was pushed so vigorously as to destroy practically all the young insects, but in both regions three or four fields were left until a considerable number made their escape. Of these that succeeded in reaching the grain field by far the greater number, and in some districts all, left before they deposited their eggs.

If there are any outbreaks from this pest next season they will be very limited and easily checked if taken in time. By driving over all the infested regions and calling attention of the farmers to this insect and the danger of allowing it to remain and multiply, an intelligent interest was created that is likely to make living rather precarious for the grasshopper that takes up his abode in this state.

An insect that did far greater damage in the state last year than the grasshoppers have done in all the years is the Hessian Fly. So far this has not been considered a very dangerous pest in spring wheat belts, especially in regions of high latitude having a dry

climate. This supposition may yet prove to be true, and the great numbers and wide range of the insect the past season may be found an exception to what we may usually expect. If our natural conditions are such as to make it difficult for this insect to pass in considerable numbers from one season to the next, then an emphasis of these conditions such as we experienced during the past season in a very long, dry and sunny fall, ought to quite exterminate the present brood.

As a rule I have found the farmers of the state unacquainted with the Hessian Fly and its habits, so a description of its life history will not be out of place.

In June the adult females, much like the mosquito in general appearance, though no more than half as large, deposit their eggs upon the leaves of the young wheat plant. The leaf selected is usually the one coming from the second joint above the ground. The egg soon hatches and a tiny grub crawls along the leaf to the stalk where it finds a place between the leaf stalk, which it appropriates as its permanent home. While it has no further power of movement, yet it feeds upon the juices of the plant and of course the straw becomes much weakened at the place where the grub is located. During the latter part of July if it is noticed that a considerable number of the straws are small and weak with but little or no grain in the heads, then the presence of the Hessian Fly may be suspected. If present it appears as a nearly transparent whitish grub about one-eighth of an inch long. Still later in the season just before harvest most of the infected straws bend over abruptly just above the second joint or where the grub is found. By this time the grub has changed appearance, for the larvae has passed into the resting stage, and is now a brown shing inactive object to which the name "flaxseed" is commonly given. In the winter wheat regions of the middle states this brood would give rise to a second one before winter that would lay eggs in the fall sown wheat, but here the "flaxseed" stage found at harvest time undoubtedly endures till the following spring or early summer before the adults emerge.

From August till the following May or June is a long time for puparia protected only by the old wheat leaf and their own thin covering, to retain their vitality.

Through the kindness of the Northern Pacific Railway Company I was enabled to visit several fields about Grafton late in November and at that time more than half of the puparia were alive and uninjured. I collected several hundred of them to make a test of their vitality, but the conditions under which they are now kept are not identical with field conditions. Only frequent visits to fields in the infested regions will enable one to determine the per cent that live through the resting period and the time at which they emerge as adults in the spring.

The remedial measures for the Hessian Fly are simple and do not entail additional expense. Badly infested fields should be cut

high and the stubble burned. If this is not possible plow in the fall or early the next season. How early will depend on what time the adults emerge, a matter not yet fully determined for this latitude, but probably the plowing should not be later than the first of June.

Parasites or unfavorable climatic conditions might destroy all of the insects making any measures of prevention unnecessary.

In the absence of state provision for work of this character, and considering the inability of the Agricultural College to spend its funds for such work, the railroads have been asked to furnish the necessary transportation, and have usually granted the request.

The incidental expenses of the trips are sometimes borne by the counties in which the damage occurs and also by citizens who are interested.

As any insect outbreak is likely to be of more than local interest it has been suggested that a small appropriation from the state should be placed at the disposal of some one whose duty it is to look after insect invasions, sending out such publications and reports as will assist in checking the damage, or in other ways furnishing such aid and advice as would naturally be expected from one holding the position of state entomologist. Small insect outbreaks are often magnified into serious affairs by papers outside the state, and in such cases the state would profit by having some one whose position enables him to speak with authority in matters of affecting her welfare and reputation. Such work is no one's duty now, and what has been undertaken in the past was done by private parties not always directly interested.

Respectfully submitted,

C. B. WALDRON,
Horticulturist.

DAIRY DEPARTMENT.

To Director J. H. Worst:

Sir: During the past year the work of the Department of Dairying has been entirely along educational lines with the exception of such feeding and milk records and tests started early in 1897 and continued to the present time.

There has been two reasons for not doing any experimental work in dairying. First, I have had to take entire charge of the Department of Military Science and Tactics, which requires from six to ten hours teaching per week, and the first half of the year taught a class in United States History five hours per week.

All other members of the station staff who have had any teaching to do have assistants who can either conduct the class work or do the experimental work under the direction of the head of the department. Second, North Dakota dairymen are in more need of instructions in the principles of buttermaking than along experimental lines.

No bulletins have been published by the department during the year, the instruction being given in such classes as attended the College, in farmers' institutes and by personal correspondence. More work of this nature is being demanded than ever before, showing an increasing tendency to engage in dairying.

There is undoubtedly a wide field for experimentation in this state, and it is only a short time when the dairymen of the state will compel matters to be so adjusted that a complete line of experiments can be carried on in this department. Under present conditions I cannot do it, neither could any one else.

The acknowledgments of the department are again due to the publishers of Hoard's Dairyman, Chicago Dairy Produce, Creamery Journal, Creamery Gazette, Practical Dairymen, Milk Reporter, Produce Review, Elgin Dairy Report, Dairy World, Dairy and Creamery, Jersey Bulletin, and Western Creamery, for copies of their valuable papers.

Respectfully submitted,

E. E. KAUFMAN,
Dairyman.

DEPARTMENT OF VETERINARY.

To Director J. H. Worst:

Sir: I take great pleasure in transmitting my first monthly report since occupying the position of chief state veterinarian. Since assuming the duties of such office nothing of any great importance has transpired. There has been no outbreak of contagious diseases to any extent. Dr. A. F. Elliot of the Seventh District reports that he destroyed six horses suffering from glanders, owned by Mr. Fitsimmons, of Neche, and the remainder of his herd was quarantined. All necessary precautions have been observed to prevent the spread any further.

There have been a number of requests for Anthrax Vaccine, and I expect to see more cattle vaccinated this coming spring than any previous year.

There have been also a number of requests for Mallein and Tuberculine.

I have been notified by the Montana state veterinarian that there exists a disease on the Montana and North Dakota line, known as cattle scab or Mange, so the district veterinarians near the line are making some investigations, and if found prevailing all the steps necessary will be taken to get the disease under control.

The general health of the stock of the state I may say is good.

Respectfully submitted,

DR. J. W. DUNHAM,

Veterinarian.

CONCLUSION.

An examination of the reports from the several heads of the Station departments show that the work of adaptation of cereals and plants to local conditions, and their improvement by selection and breeding is continued from former years, and that due attention is given to diseases affecting plants and grains. Methods of cultivation are given considerable attention, and animal husbandry comes in with a fair share of attention in a general as well as experimental way.

New questions are constantly arising that should be given larger attention, and many useful experiments that should be made have to be deferred for lack of funds to employ the requisite help. The Station will continue in the future as in the past to work along the most practical and useful lines, giving preference to what is useful to the farmer, rather than what may prove more interesting than practical.

Respectfully submitted,

J. H. WORST,

Director.

STATEMENT.

GOVERNMENT AGRICULTURAL EXPERIMENT STATION FOR NORTH DAKOTA IN ACCOUNT WITH THE UNITED STATES APPROPRIATION, 1898-9.

DEBTOR.

To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30th, 1899, as per Act of Congress approved March 2nd, 1897	$15,000.00

CREDITOR.

By salaries	$ 7,725.00
Labor	2,870.77
Publications	1,033.27
Postage and stationery	144.67
Heat, light and water	331.11
Chemical supplies	.30
Seeds, plats and sundry supplies	265.01
Freight and express	178.26
Feeding stuffs	192.50
Library	28.50
Tools, implements and machinery	406.35
Furniture and fixtures	18.75
Scientific apparatus	50.50
Live stock	800.00
Traveling expenses	133.35
Contingent expenses	45.75
Building and repairs	740.91
Fertilizers	35.00
	$15,000.00

SUPPLEMENTARY STATEMENT.

DEBTOR.

To balance on hand June 30th, 1898	$ 494.34
To receipts from other sources than the United States for the year ending June 30, 1899	2,782.91
	$ 3,277.25

CREDITOR.

By salaries	$ 180.00
Labor	1,724.92
Heat, light and water	30.68
Seeds, plants and sundry supplies	956.46
Feeding stuffs	55.80
Tools, implements and machin ry	19.14
Live stock	276.50
Contingent expenses	25.00
Building and repairs	8.75
Total amount	$ 3,277.25

R. A. SHATTUCK,
Secretary.